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CLINICAL INVESTIGATIONS

# Lysis of adhesions and epidural injection of steroid/local anaesthetic during epiduroscopy potentially alleviate low back and leg pain in elderly patients with lumbar spinal stenosis†

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**Background.** Lumbar spinal stenosis causes various forms of back or leg pain, and is recognized with increasing frequency in elderly patients whose physical status is not always suitable for surgery. Epiduroscopy, a new, minimally invasive diagnostic and therapeutic technique, may be useful for pain relief in such patients. We investigated the epiduroscopic findings and immediate and long-term changes in back and leg pain after epiduroscopy in elderly patients with spinal stenosis.

**Methods.** Patients with degenerative lumbar spinal stenosis ($n$=58, median age 71 yr) were divided into two groups based on presenting symptoms: a monosegmental group ($n$=34) and a multisegmental group ($n$=24). Each patient underwent epiduroscopy, and the findings were evaluated using visual analogue scales for low back and leg symptoms. Epiduroscopy included breaking down adhesions in the epidural space by injections of saline, and injection of steroids/local anaesthetic.

**Results.** Epiduroscopy showed that the amount of fatty tissue and the degree of vascularity were greater in the monosegmental group than in the multisegmental group. Relief of low back pain was observed up to 12 months after epiduroscopy in both groups. Relief of leg pain was evident up to 12 months after epiduroscopy in the monosegmental group, and up to 3 months after epiduroscopy in the multisegmental group. None of the patients showed deterioration of motor or sensory deficits during follow-up. One patient was excluded from analysis because of accidental dural puncture during the procedure.

**Conclusions.** The findings of epiduroscopy corresponded to the symptoms. Epiduroscopy may reduce low back and leg pain in elderly patients with degenerative lumbar spinal stenosis, particularly those with radiculopathy.

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**Keywords**: anaesthetic techniques, epiduroscopy; complications, lumbar spinal stenosis; pain, leg; pain, lower back

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Degenerative lumbar spinal stenosis is a common disease that causes low back pain and a variety of symptoms in the legs.[1] Currently, most patients are treated conservatively.[2] However, low back pain and leg pain in patients with lumbar spinal stenosis sometimes show only temporary relief with conservative treatment, such as epidural block.[3] Surgery is recommended for patients who do not respond to conservative treatment, but symptomatic spinal stenosis is recognized with increasing frequency in older patients whose physical status is not always suitable for surgery.

Epiduroscopy is a new technique for treatment of chronic low back pain.[4 5] At the present time, only a few prospective studies have been conducted to establish the benefits of epiduroscopy,[6 7] although retrospective studies have described the clinical effectiveness and cost-effectiveness of epiduroscopy in patients with herniated disks or severe low back pain after back surgery.[4 8]

We postulated that epiduroscopy could be a good therapeutic choice for elderly patients if it has a positive effect on spinal stenosis. However, the effects and theoretical basis of epiduroscopy have not been thoroughly investigated in selected patients with spinal stenosis. In this study, we

†This article is accompanied by Editorial I.

compared epiduroscopic findings and changes in symptoms after an identical epiduroscopy procedure in ill-defined groups of patients with degenerative lumbar spinal stenosis.

## Materials and methods

### *Patients*

The study was approved by the local ethics committee (Bioethics Committee of Jichi Medical School), and written informed consent was obtained from all patients. Fifty-eight patients with degenerative lumbar spinal stenosis who met the following physical and radiographic findings were included in this study. All patients had low back and leg symptoms with positive postural factors, that were not cured by conservative therapy consisting of physiotherapy, bracing, non-steroidal anti-inflammatory drugs (NSAIDs) and sporadic epidural injection of local anaesthetics with or without steroids for at least 3 months. Positive postural factors were identified, including leg symptoms evoked or accentuated by walking or by hyperextension of the lumbar spine and relieved on subsequent flexion. Spinal stenosis was confirmed by a minimum cross-sectional area of the dural sac[9] of <100 $mm^2$ by either computed tomography with myelography or magnetic resonance imaging. All patients had received epidural block before epiduroscopy. In these epidural blocks, we used local anaesthetic but not always steroids as well. All patients responded well to the epidural blocks, but the symptoms relapsed within 1 week regardless of whether we used steroids. The median (range) time between the latest epidural steroid/local anaesthetic injection and epiduroscopy was 4 (2–14) weeks. All patients used NSAIDs, but none had been treated with opioids or spinal cord stimulation, or received psychotherapeutic management. Patients who developed signs of progressive motor disorders or incontinence were excluded. Patients with a history of prior spinal surgery, obstructive arteriosclerosis or coagulopathy were also excluded.

The patients were classified into the following two groups based on leg symptoms that were evoked or accentuated during walking: (i) a monosegmental group, characterized by radicular pain ($n$=34); and (ii) a multisegmental group, characterized by burning sensations, dysaesthesia or paraesthesia in the plantar region or in a wider leg or perineal area ($n$=24). Patients who exhibited mixed symptoms of the two groups were enrolled in the multisegmental group.

### *Technique of epiduroscopy*

The patient was placed in the prone position on a horizontal operating table. A pillow was placed under the abdomen to minimize lumbar lordosis. After sterile preparation of the surgical field, an 18-gauge Tuohy needle was introduced into the sacral hiatus, and its tip was confirmed to be in the caudal epidural space by lateral X-ray or by injection of a contrast medium (iotrolan 10 ml, Isovist 240®; Schering, Osaka, Japan) through the needle. A 0.8-mm guide wire was then inserted through the needle under fluoroscopic guidance. Using the Seldinger technique, the 4-mm (8.5 F) introducer (4005; Mylotec, Ruswell, GA, USA) with a dilator was advanced over the guide wire into the sacral epidural space. After removal of the dilator and the guide wire, a 0.9-mm endoscope (3000E; Mylotec) covered with a video-guided catheter (2000; Mylotec) was introduced into the epidural space through the introducer. The endoscope was gently steered and advanced in a cephalad direction under direct vision in the epidural space. Fluoroscopy was used to determine the vertebral level to which the endoscope tip was advanced in the epidural space. In order to obtain a good visual field, the epidural space was irrigated and distended by infusion of saline during the procedure. When adhesions or heavy connective tissues were detected in the epidural space, they were broken down by bolus injections of a small amount of saline through the catheter combined with careful and gentle movement of the catheter. When a sufficient field to steer the fibrescope could not be obtained, or paraesthesia or resistance was noted, no attempt was made to steer the epiduroscope into such an area. Before and after lysis of adhesion(s), epidurography was performed to determine if the connective tissue strands interfered with the nerve root. The procedure was terminated when epidurography demonstrated that the contrast medium had reached the affected nerve root sheaths. The painful nerve root, suspected by neurophysiological and radiographic examination, was confirmed by reproducing pain when the epiduroscope gently touched the nerve root. At the end of the procedure, lidocaine 1% 8 ml and triamcinolone acetate 40 mg were injected around the area through the catheter. The mean (range) total volume of saline used during the procedure was 298 (100–650) ml. During the procedure, propofol 2–5 mg $ml^{-1}$ $h^{-1}$ was infused i.v. to minimize anxiety and discomfort. The drug kept the patient sedated but awake and conscious. One patient in the multisegmental group, in whom dural puncture occurred accidentally during epiduroscopy, was excluded from the analysis.

### *Follow-up*

Each patient underwent a standard physical examination and was asked to complete a 100-mm visual analogue scale (VAS) questionnaire, in which 0 mm represented no pain and 100 mm the worst imaginable pain, for low back pain and leg symptoms on movement during activities of daily living, before epiduroscopy and 1 week and 1, 2, 3, 6 and 12 months after epiduroscopy. Motor deficit was graded as marked (grade 3), mild (4) or none (5) by quantitative manual muscle testing. Sensory deficit was graded as marked (50% hypaesthesia), mild (>50% and <100% hypaesthesia) or none by light touch sensation. Conservative therapy performed before epiduroscopy was continued during the 12-month follow-up period in each patient. When patients developed multiple signs of progressive motor disorders, including

significant motor weakness in the lower extremities and bladder dysfunction, definitive surgical management was considered.

### *Data analysis*

The cross-sectional area of the dural sac at the narrowest point was scanned into a personal computer, and measured using image analysis software (NIH image analysis software, version 1.6, written by Wayne Rasband, National Institutes of Health, Bethesda, MD, USA). Radiographs of each patient were reviewed by a physician who was unaware of the clinical status of the patient.

The epiduroscopic findings[10] were analysed visually by two independent investigators who did not have access to the patients' medical histories. Furthermore, they were unaware of the group to which the patient had been assigned. The epiduroscopic findings at the vertebral levels involved were divided into four categories for analysis: amount of fatty tissue; amount of fibrous connective tissue; degree of adhesion; and degree of vascularity. The four areas of analysis were scored using the following grading system: 1=none or extremely small; 2=moderate; 3=considerable. To reach consensus when a discrepancy between two observers in each finding was noted, the difference was resolved by a third experienced investigator.

Data were expressed as median (range) for age, height, weight, duration of symptoms, radiological findings and the VAS scores. Differences between groups were examined for statistical significance using the contingency table and Mann–Whitney *U*-tests. A *P*-value of less than 0.05 was considered statistically significant.

## Results

The male/female ratio, age, height, weight, duration of symptoms, walking distance, neurological deficits (motor and sensory) and medications were comparable between the groups (Table 1). Radiological findings in the monosegmental group consisted of degenerative spondylolisthesis (*n*=11) and degenerative spondylosis (*n*=23), and in the multisegmental group the findings were degenerative spondylolisthesis (*n*=12) and degenerative spondylosis (*n*=11). There were no differences between the groups in the cross-sectional area of the dural sac. The levels involved included L4–5 (*n*=21) and L3–4 (*n*=13) in the monosegmental group and L4–5 (*n*=19) and L3–4 (*n*=4) in the multisegmental group.

Epiduroscopic findings (Fig. 1) revealed that the amount of fatty tissue and degree of vascularity at the vertebral levels involved were greater in the monosegmental group than in the multisegmental group. No significant differences were detected among the groups in the amount of fibrous connective tissue and degree of adhesion.

Figure 2A shows the epidural space in a 65-yr-old woman, a representative patient of the monosegmental group. The upper part represents fatty tissue while the lower part is the dura mater. Fibrous connective tissue was seen between the fatty tissue and dura mater. Fine blood vessels formed complex vascular networks in the fatty and connective tissues. Figure 2B shows the left L5 nerve root in the epidural

**Table 1** Patient characteristics. Data are median and (range) for age, mean (SD) for height and weight, or number of patients

| | Monosegmental group | Multisegmental group |
|---|---|---|
| *n* | 34 | 24 (1 excluded) |
| Gender (M/F) | 17/17 | 7/16 |
| Age (years) | 72 (45–92) | 70 (51–81) |
| Height (cm) | 149 (10) | 151 (7) |
| Weight (kg) | 54 (11) | 52 (7) |
| Duration of symptoms (months) | 21 (4–360) | 60 (5–600) |
| Walking distance (no. of patients) | | |
| <100 m | 11 | 5 |
| 100–500 m | 14 | 15 |
| >500 m | 9 | 3 |
| Neurological deficit (no. of patients) | | |
| Motor | | |
| Marked | 0 | 0 |
| Mild | 12 | 5 |
| None | 20 | 18 |
| Sensory | | |
| Marked | 2 | 3 |
| Mild | 22 | 9 |
| None | 10 | 11 |
| Medication (no. of patients) | | |
| NSAID | 34 | 23 |
| Opioid | 0 | 0 |
| Dural sac area ($mm^2$) | 58.6 (37.1–97.4) | 56.0 (33.1–90.4) |
| Involved level (no. of patients) | | |
| L3–4 | 3 | 4 |
| L4–5 | 21 | 19 |

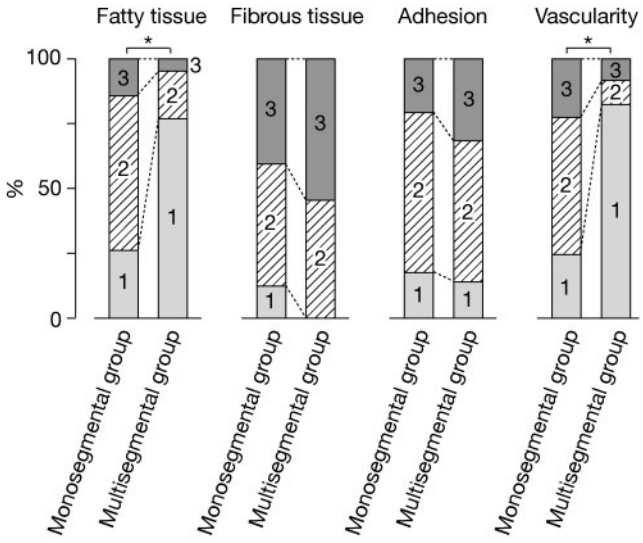


**Fig 1** Proportions of patients with various epiduroscopic findings in the monosegmental and multisegmental groups. Dotted bars indicate score 1 (none or extremely small), shaded bars indicate score 2 (moderate) and solid bars indicate score 3 (considerable). Significant differences between the groups were found in the median values for amount of fatty tissue and degree of vascularity. No significant differences were found between the groups in the median values for the amount of fibrous connective tissue and degree of adhesion. *$P$<0.05.

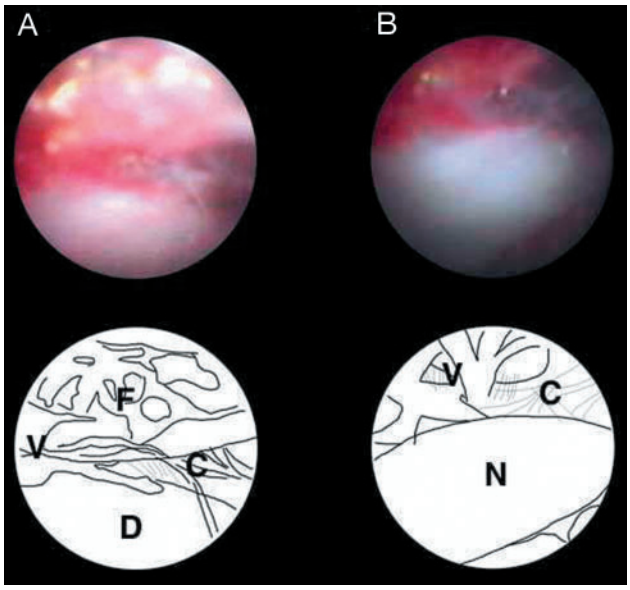


**Fig 2** Photographs (top) and schematic drawings (bottom) of the epidural space in a 65-yr-old woman from the monosegmental group. D=dura mater; F=fatty tissue; V=blood vessels; C=fibrous connective tissue; N=nerve root. Fine blood vessels formed complex vascular networks in the fatty and fibrous connective tissues (A). Note the congestion of the fatty and connective tissues around the left L5 nerve root (B).

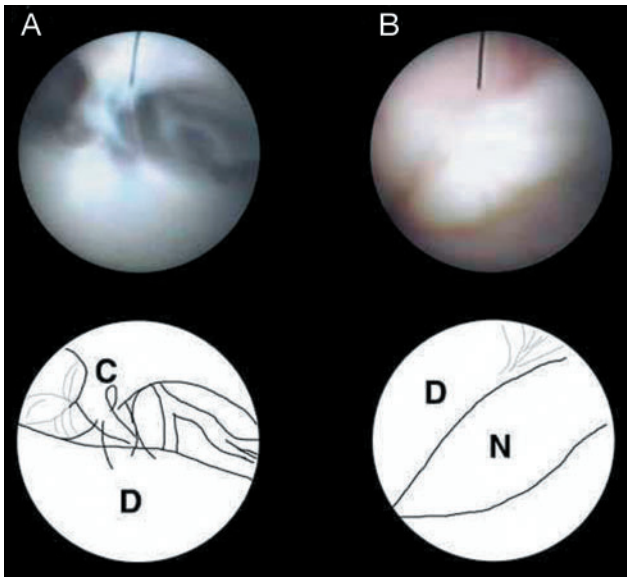


**Fig 3** Photographs (top) and schematic drawings (bottom) of the epidural space in a 75-yr-old woman from the multisegmental group. D=dura mater; V=blood vessels; C=fibrous connective tissue; N=nerve root. Fatty tissue was not detected at this L4–5 vertebral level. Stretched fibrous connective tissue with reduced vascularity was seen in the epidural space (A). The perineural tissue of the right L5 nerve root was ischaemic (B).

space in this patient. Around the nerve root, congestion of the fatty and connective tissues can be seen in the upper and lower parts of the photograph.

Figure 3A shows the epidural space in a 75-yr-old woman, a representative patient of the multisegmental group. Stretched fibrous connective tissue with hypovascularity was noted in

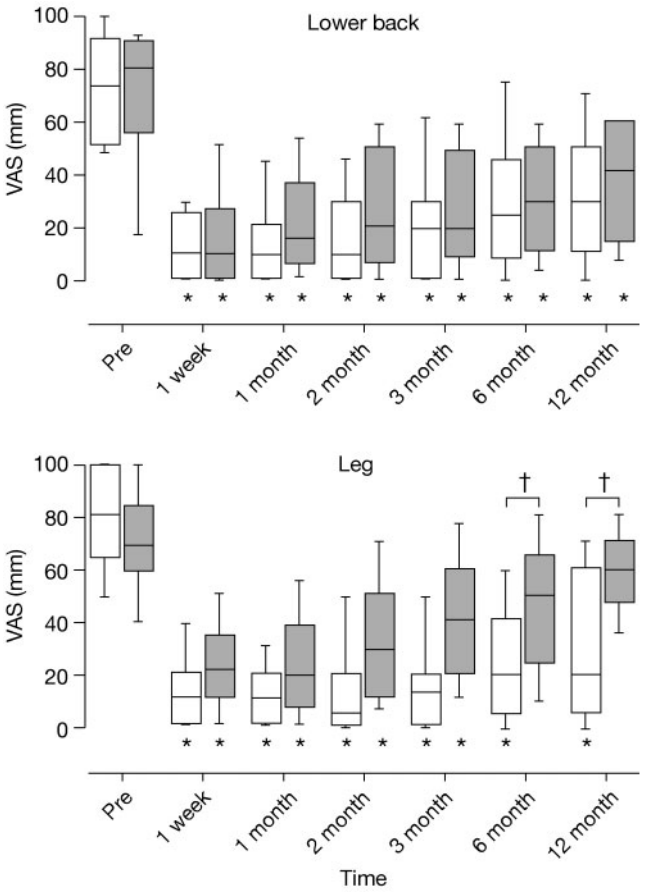


**Fig 4** Changes in VAS scores for low back (upper panel) and leg (lower panel) symptoms. Open boxes, monosegmental group; grey boxes, multisegmental group. In the box and whisker plots, the horizontal line within the box represents the median value and the top and bottom boundaries of the box represent the 25th and 75th percentiles, respectively. **P*<0.05 compared with the value before epiduroscopy; †*P*<0.05 compared between the two groups.

the epidural space. No fatty tissue was detected at this vertebral level. Figure 3B shows the right L5 nerve root in the epidural space. The top represents the dura mater while the bottom is the inner layer of the spinal canal. Low vascularity was noted around the nerve root.

At baseline (before epiduroscopy), there were no significant differences between the groups with regard to the VAS scores for low back pain (Fig. 4). The VAS score for low back pain decreased after epiduroscopy in both groups and improvement of VAS scores was persistently recorded during the subsequent follow-up period up to 12 months in both groups. There were no significant differences between the groups during the follow-up period.

There were no significant differences at baseline between the groups with regard to the VAS scores for leg symptoms (Fig. 4). The VAS score for leg symptoms decreased after epiduroscopy in both groups. Improvement of VAS scores was persistently recorded during the subsequent follow-up period up to 12 months in the monosegmental group, and for the subsequent 3 months in the multisegmental group. The

VAS scores 6 and 12 months after epiduroscopy were significantly lower in the monosegmental group than in the multisegmental group.

None of the patients showed deterioration of motor or sensory deficits requiring surgery during the follow-up period. There were no differences between the types and doses of medications taken before epiduroscopy and during follow-up in both groups.

## Discussion

Our results demonstrate the positive effects of epiduroscopy on low back pain for up to 12 months in both groups, whereas relief of leg-related symptoms lasted longer in patients with a monosegmental pain pattern than in those with a multisegmental pain pattern. Epiduroscopy showed that the amounts of fatty tissue and vascularity were greater in patients with a monosegmental pain pattern than in patients with a multisegmental pain pattern. Thus, epiduroscopy allowed identification of the reason for discrepancies in the positive effects of the procedure. Our results suggest that lysis of adhesions and epidural steroid/local anaesthetic applied during epiduroscopy could be useful for elderly patients with lumbar spinal stenosis, in particular those with a monosegmental pain pattern.

Several factors could be responsible for post-epiduroscopy pain relief in patients with spinal stenosis. First, we administered local anaesthetics and steroids during epiduroscopy. Local anaesthetics induce sympathetic nerve blockade and therefore improve blood flow to the ischaemic neural elements.[11] Steroids reduce inflammatory oedema of the injured nerve root and therefore improve intraneural blood flow.[12] Although the efficacy of epidural steroids in patients with spinal stenosis is controversial,[13 14] the lack of positive effects in clinical reports may in part reflect incorrect placement of the injectate. We suggest that initial improvement of symptoms after epiduroscopy may reflect local anaesthetics and steroids reaching the area causing these symptoms.

Secondly, the epidural space was distended by administration of saline during epiduroscopy. Several groups have reported the importance of inflammatory mediators in causing low back and leg pain.[15 16] We suggest that pain relief in these patients may also be related in part to the effect of saline in diluting local tissue concentrations of inflammatory mediators. Lastly, lysis of perineural adhesions during epiduroscopy may play a role in the lasting relief of pain. In the epidural space in our patients with spinal stenosis, we observed adhesions and fibrosis, which can develop as a result of inflammation around the involved neural tissues.[17] Fibrosis causes leg pain by interfering with the mobility of the dural sleeves of the spinal roots.[18] We suggest that mobility of the nerve roots may be restored to some extent after epiduroscopy and that this may contribute to the long-term pain relief, exceeding the intrinsic effective duration of epidural injectates.

In this regard, lysis of epidural adhesions is a controversial topic in the treatment of patients with failed back surgery. Several groups have stressed that lysis of epidural adhesions is an effective therapeutic option,[4 7 8] whereas others asserted that there is no correlation between therapeutic effect and the degree of lysis of epidural adhesions.[19] In addition, hyaluronidase, clonidine and hypertonic saline have been used to enhance the effect of lysis of epidural adhesions.[6 20] Since our study employed an identical procedure of epiduroscopy without hyaluronidase, clonidine or hypertonic saline in all patients with spinal stenosis, it may be difficult from our study to determine whether lysis of adhesions was effective in reducing symptoms. Nevertheless, lysis of adhesions may contribute to the correct placement of epidural injectates in the involved region of spinal stenosis, since epiduroscopy showed various amounts of fibrous connective tissue and adhesions at the involved vertebral levels.

Our results showed differences between the groups with regard to the duration of leg pain relief. Better long-term effects were observed in the monosegmental group, whereas the reduced leg pain in the multisegmental group reappeared with time. Consistent with our results, previous reports in patients with chronic refractory back pain or failed back surgery indicated that results after epiduroscopy vary between individuals.[7 21] In patients with spinal stenosis, the symptoms reflect a combination of pathological processes, such as interruption of blood flow, venous congestion, ischaemia, axonal damage and intraneural fibrosis.[22 23] We suggest that some of these processes may be modified after lysis of adhesions and that this presumably enhances the effect of lysis *per se*.

In this regard, the epiduroscopic findings may themselves explain the discrepancies in the long-term outcome between the groups. Our epiduroscopy showed pronounced vascularity at the involved vertebral level in the monosegmental group. Assuming marked inflammation exists in this group, the efficacy of epidural steroid may probably be pronounced in the monosegmental group. Furthermore, in the same group, the presence of fatty tissue may be favourable to nerve root mobility after lysis of adhesions. In contrast, hypovascularity was observed in the multisegmental group. It is possible that the leg symptoms in the multisegmental group are due to reduced blood flow to the nerve and that such ischaemia may have improved after lysis of adhesions but subsequently relapsed with time. Our comparison between groups of spinal stenosis patients suggests that epiduroscopic findings may reflect pathological processes in patients with spinal stenosis and that radiculopathy may be a key criterion for selection of patients suitable for the lysis of adhesions and epidural steroid/local anaesthetic during epiduroscopy.

We encountered accidental dural puncture in one patient of the multisegmental group. However, the patient did not subsequently exhibit headache or neurological deterioration. Lateral radiographs of this patient revealed severe degenerative spondylolisthesis (percentage of slip, 19%). Spondylolisthesis is generally limited to a maximum of 25–30% of the

anterior–posterior diameter of the spinal canal.[24] In such patients with spondylolisthesis, epiduroscopy around the stenotic area is difficult, since the spinal nerve root and dorsal ganglia are particularly sensitive to mechanical compression.[25] Although minimizing lumbar lordosis with a pillow under the abdomen can widen the spinal canal during epiduroscopy,[26] careful attention must be paid to new signs of neural damage in patients with severe spondylolisthesis.

We selected patients with degenerative lumbar spinal stenosis, paying special attention to the clinical and radiological findings.[1 27 28] However, selection bias may exist in our patient population. We considered surgery rather than epiduroscopy in patients who had already developed signs of progressive motor disorders or incontinence, and therefore excluded such patients from this study. Therefore, it may be difficult from our study to determine whether epiduroscopy affects the natural course of untreated lumbar spinal stenosis,[2] in which 15% of patients show progressive deterioration, 15% show improvement and 70% show no change. Further prospective controlled studies are necessary for a comprehensive evaluation of the effects of epiduroscopy.

With regard to the classification of spinal stenosis, the international classification, which is based on the anatomical location of such narrowing, is used widely,[1] though it is controversial. Patients categorized with degenerative spondylolisthesis often overlap with others: central, lateral, or both. Furthermore, the radiographic findings do not correspond with the symptoms, since the symptoms of stenosis reflect not only abnormal narrowing but also dynamic factors such as walking. On the other hand, spinal stenosis can be classified functionally, based on the subjective symptoms and the findings on physical examination, into three types: (i) a radicular type, characterized by radicular pain; (ii) a cauda equina type, characterized by burning sensations, dysaesthesia or paraesthesia in the plantar region or in a wider leg or perineal area; and (iii) a mixed type.[23 29] Clinical practice suggests that there are differences in the pathological processes between the first type and the last two types, since the responses to nerve root block, sympathetic nerve block or spinal angiography in the former type are different from those in the last two types.[23 30] Although radiographic findings are necessary for detecting spinal stenosis, we used the functional classification in this study.

Although definite evidence cannot be drawn from this study about the efficacy of the technique without having a control group, the marked decrease in median VAS observed in our study suggests that epiduroscopy could be an option for pain management of radiculopathy caused by lumbar spinal stenosis.

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